

IN THE SPECIFICATION:

Please replace the last paragraph of page 5 (continuing to pages 6-7) of the Disclosure currently on file with the following paragraph:

Various studies have been found that in a case where [[the]] lacking in oxygen composition of aluminum oxide is 10% or less of the stoichiometric composition, that is, in a case of:  $Al_2O_{3-x}$  ( $X \leq 0.3$ ) in the chemical formula, lowering of resistance to damp caused by oxygen defects in the film, an increase in the absorption of light and an increase of the number of surface states caused at the interface of semiconductor and aluminum oxide due to defects are each at a negligible level, and cause no undesired effects on the device characteristics. Fig. 11 shows occurrence of film peeling-off after keeping for 300 hours under the conditions of a temperature of  $85^{\circ}C$  and a humidity of 85%. As apparent from the graph, film peeling-off did not occur in a case where  $X \leq 0.3$ . Fig. 12 shows the dependence of an extinction coefficient of an aluminum oxide film on the oxygen concentration. The extinction coefficient shows the extent of light absorption, and the light absorption did not occur in a case where  $X \leq 0.2$ , and light absorption caused no practical problem even at  $X = 0.3$ . Fig. 13 shows the dependence of critical load on the oxygen concentration in a scratch test. The critical load is a load at which film peeling-off starts in the scratch test, which is an index for adhesion. It was found that, in an aluminum oxide film with no oxygen defects, the film was scarcely adhered and highly liable to be peeled off. The adhesion is improved in the loss of oxygen state and it can be seen that adhesion is improved in the loss of oxygen state, and a preferred film has the highest adhesion at  $X = 0.2$ . The adhesion is rather lowered when the loss of oxygen component increases more. In view of experience, there is no practical problem in a case where the critical load is 30 mN or more. Fig. 14 shows a surface state density at an interface of InP and aluminum oxide film obtained by measurement for characteristics of high frequency capacitance/voltage characteristics. At  $X = 0.2$  or less, the surface states density is less than the detectable limit and the amount thereof is slight also at  $X = 0.3$ . As described above, it has been found that favorable characteristics with no practical problems at all are shown at  $X \leq 0.3$  as described above. In particular, in a case where  $Al_2O_{3-x}$  ( $X \leq 0.2$ ), each of lowering in the resistance to damp, increase in the light absorption and increase of the surface states density is less than the detectable limit and it is extremely satisfactory. Further, for the spontaneous oxide film formed at the facet by contact with atmospheric air after the formation of the facet by cleavage or the like, oxygen is absorbed in aluminum oxide by the formation of aluminum oxide in the state of lacking in oxygen, to obtain a clean interface of semiconductor and aluminum oxide. It is probably that this improved adhesion between the reflection film and the semiconductor as shown in Fig. 13.

Please replace the last paragraph of page 7 (continuing to page 8) of the Disclosure currently on file with the following paragraph:

Since diffusion of oxygen to the semiconductor can be suppressed and bonding of semiconductor-constituting elements, particularly, aluminum and arsenic with oxygen can be prevented by forming the state of lacking in oxygen, facet deterioration can be minimized. Fig. 15 shows a result of conducting an automatic power controlled operation test at a temperature of 85°C and then allowing an operation current to flow till the laser diode emits the maximum optical power and examining whether catastrophic optical damages (COD) are caused or not. The catastrophic optical damages were not caused in  $X \geq 0.03$  (as shown by symbols "O" in Fig. 15, catastrophic optical damage was not caused in the continuous operation test till 5000 hours). Fig. 16 shows a result of conducting an automatic power controlled operation test for 100 hours, then applying a pulsative DC voltage and examining a voltage causing electrostatic destroy deterioration. The electrostatic destroy deterioration was no more caused in  $X \geq 0.03$  and at 500 V or lower and, particularly, deterioration was no more caused upon application of a voltage even at 1000 V in  $X \geq 0.1$  (symbol "O" shown in Fig. 16). As described above in a case where loss of oxygen of at least 1% or more relative to the stoichiometric composition is present, that is, at  $\text{Al}_2\text{O}_{3-x}$  ( $0.03 \leq X$ ), the effects for minimizing catastrophic optical damages (COD) deterioration and deterioration of electrostatic breakdown voltage is remarkable. In particular, in a case where  $\text{Al}_2\text{O}_{3-x}$  ( $0.1 \leq X$ ), the effect of minimizing catastrophic optical damages (COD) deterioration and deterioration of electrostatic destroyed minimum voltage is most favorable, and the effect tends to be saturated.

Please replace the last paragraph of page 13 (continuing to pages 14-15) of the Disclosure currently on file with the following paragraph:

**<Example 1>**

A first example of the invention is to be explained with reference to Figs. 2A, 2B and 3. This example is applied to a high power laser diode for 0.65  $\mu\text{m}$  band used for writing in optical disks or magneto-optical disks. Fig. 2A shows a cross-sectional structure, Fig. 2B is an enlarged view of an active layer, and Fig. 3 shows planer structure. Then a device manufacturing method is to be described. On an n-typed GaAs substrate 201, are formed successively, a GaAs buffer layer 202, an n-typed  $(\text{Al}_x\text{Ga}_{1-x})\text{InP}$  clad layer 203 lattice matched to GaAs ( $x = 0.7$ ), a strained quantum well active layer 207 comprising  $(\text{Al}_y\text{Ga}_{1-y})\text{InP}$  barrier layers ( $y = 0.45$ , barrier layer thickness 4 nm) 204 lattice matched to GaAs,  $\text{In}_z\text{Ga}_{1-z}\text{P}$  strained quantum well layers ( $z = 0.58$ , well layer thickness 87 nm) 205, and  $(\text{Al}_s\text{Ga}_{1-s})\text{InP}$  SCH (Separate Confinement Heterostructure) layers ( $s = 0.55$ , barrier wall layer thickness 4 nm) 206, a p-typed  $(\text{Al}_t\text{Ga}_{1-t})\text{InP}$  clad layer ( $t = 0.7$ ) 208 lattice matched to GaAs, a p-typed InGaP etching stopping layer 209 lattice matched to GaAs, and a p-typed  $(\text{Al}_u\text{Ga}_{1-u})\text{InP}$  clad layer ( $u = 0.7$ ) 210 and a p-typed  $\text{Al}_v\text{Ga}_{1-v}\text{As}$  cap layer ( $v = 0.7$ ) 211 by an MOVPE method, a CBE method or a MBE method. Then, a ridge as shown in Fig. 2A is formed by photo-etching step using an oxide film as a mask. Etching in this step may be applied by any method such as a wet, RIE, RIBE, or ion milling method. Etching is stopped at the p-InGaP etching stopping layer 209 so that it does not reach the strained quantum well active layer 207. Then, an n-typed GaAs current blocking layer 212 is grown selectively by an MOVPE method as shown in Fig. 2A using the oxide

film that was used as an etching mask as a selective growing mask. Then, a wafer is taken out of a growing furnace, and the oxide film used as the selective growing mask is removed by etching. Thereafter, a p-typed GaAs contact layer 213 is formed by an MOVPE method or MBE method. After forming an ohmic contact electrode 214 on p-typed GaAs, and an ohmic contact electrode 215 on n-typed GaAs, a laser diode having an optical resonator length of about 600  $\mu\text{m}$  is obtained by a cleaving method. Then, as shown in Fig. 3, by using a helicon wave plasma excited reactive vapor deposition method, an aluminum oxide ( $\text{Al}_2\text{O}_{2.9}$ ) film lacking 3.3% oxygen with a thickness of  $\lambda/4$  ( $\lambda$ : oscillation wavelength) is formed thereby forming a low reflection film 216 on the forward facet ( $z = 1$ ) of the device. In addition, a high reflection film 217 comprising an aluminum oxide ( $\text{Al}_2\text{O}_{2.85}$ ) film 219 lacking 5% oxygen and a 3-periodical titanium oxide film 220 [[is]] formed on the backward facet ( $z = 0$ ) of the device. Additional facet protection films or facet reflection films having an aluminum oxide film lacking oxygen may be added on the backward facet of the device. Aluminum oxide is deposited by using a reactive sputtering method or ion beam sputtering method. In this step, deposition is conducted by irradiating a metal aluminum target with plasma or ion beams by using a gas mixture of an argon gas and an oxygen gas.